Gravitational Wave Search With The Clock Mission

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Doppler tracking of distant spacecraft is the only method currently available to search for gravitational waves in the low-frequency (~0.0001-0.1 Hz) band. In this technique, the Doppler system measures the relative dimensionless velocity $2\Delta v/c = \Delta f/f_0$ between the earth and the spacecraft as a function of time, where Δf is the frequency perturbation and f_0 is the nominal frequency of the radio link. A gravitational wave of amplitude h incident on this system causes small frequency perturbations, of order h in $\Delta f/f_0$, replicated three times in the record (Estabrook and Wahlquist 1975).

Experiments to date and those planned for the near future all involve "two-way" Doppler-i.e., Doppler measured on the earth with a frequency standard driving the transmit and receive chains of the ground station. If, as on the proposed Clock Mission, there is an additional frequency standard on the spacecraft and a suitable earth-spacecraft radio system, some noise sources can be isolated and removed from the data (Smarr et al. 983; Vessot 1984; Piran et al. 1986). Here I review how an on-board frequency standard might be employed and discuss the probable limiting sensitivity of a Clock Mission gravitational wave experiment.

References

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